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(54) **LENS MODULE AND DIGITAL CAMERA MODULE USING SAME**

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(51) **Int. Cl.**

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G02B 7/02	(2006.01)
G03B 3/00	(2006.01)
G03B 13/00	(2006.01)
H04N 5/225	(2006.01)

(52) **U.S. Cl.** **396/144**; 359/819; 348/340; 348/342

(58) **Field of Classification Search** 396/144
See application file for complete search history.

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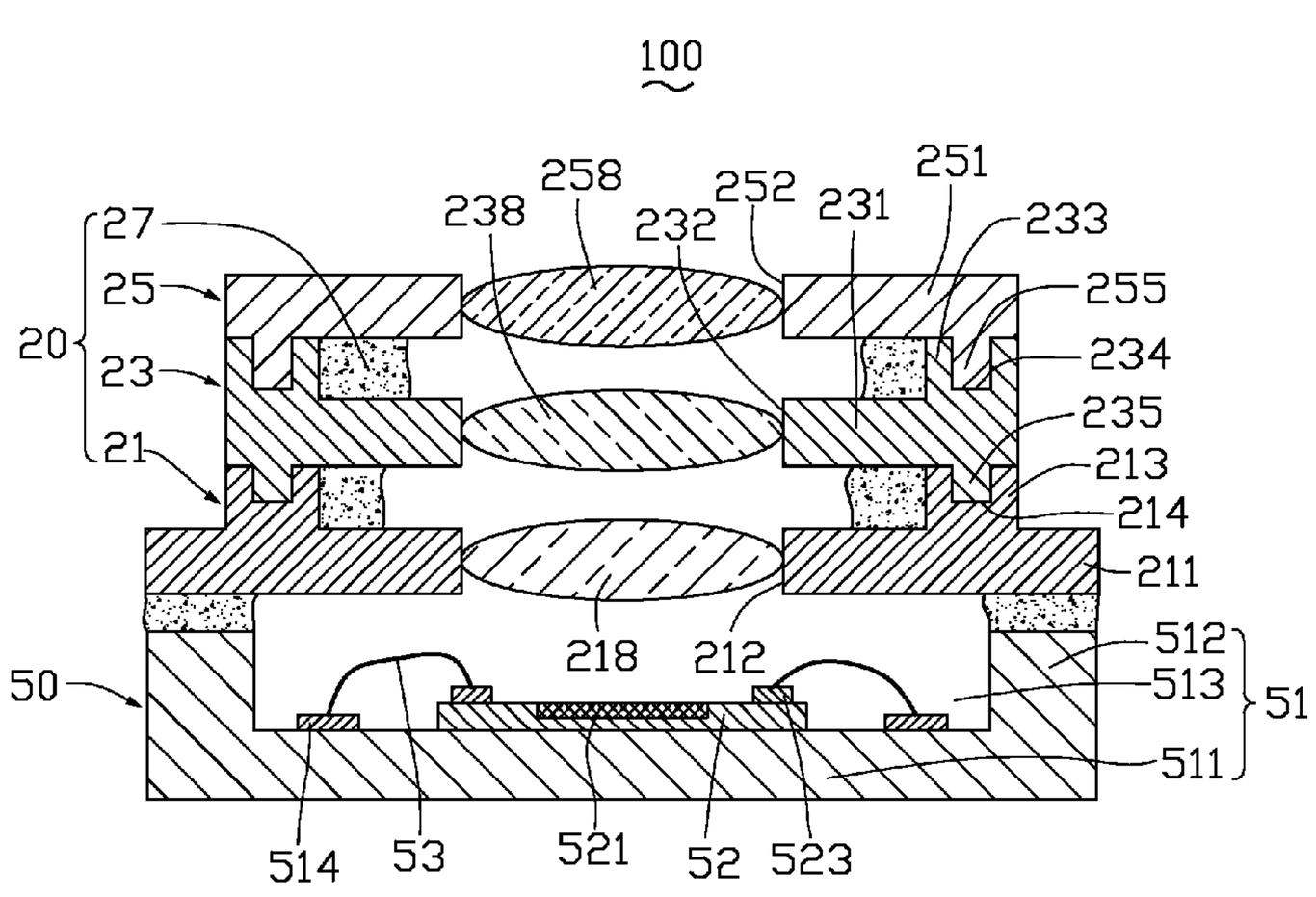
(57) **ABSTRACT**

A digital camera module (**100**) includes a lens module (**20**) and a chip package (**50**) mounted in a light path of the lens module. The lens module includes a first lens assembly (**21**) and a second lens assembly (**23**). The first lens assembly includes a first fixture (**211**) having a through hole (**212**) defined therein and at least one lens (**218**) received in the through hole. The second assembly includes a second fixture (**23**) having a through hole (**232**) defined therein and at least one lens (**238**) attached therein. One of the first fixture and the second fixture has a slotted annular ring (**213**) protruding therefrom with an annular slot (**214**) defined therein. The other has a male annular ring (**235**) extending therefrom, and the slotted annular ring and the male annular ring matingly engage with each other to fix the first lens assembly and second assembly together.

13 Claims, 4 Drawing Sheets



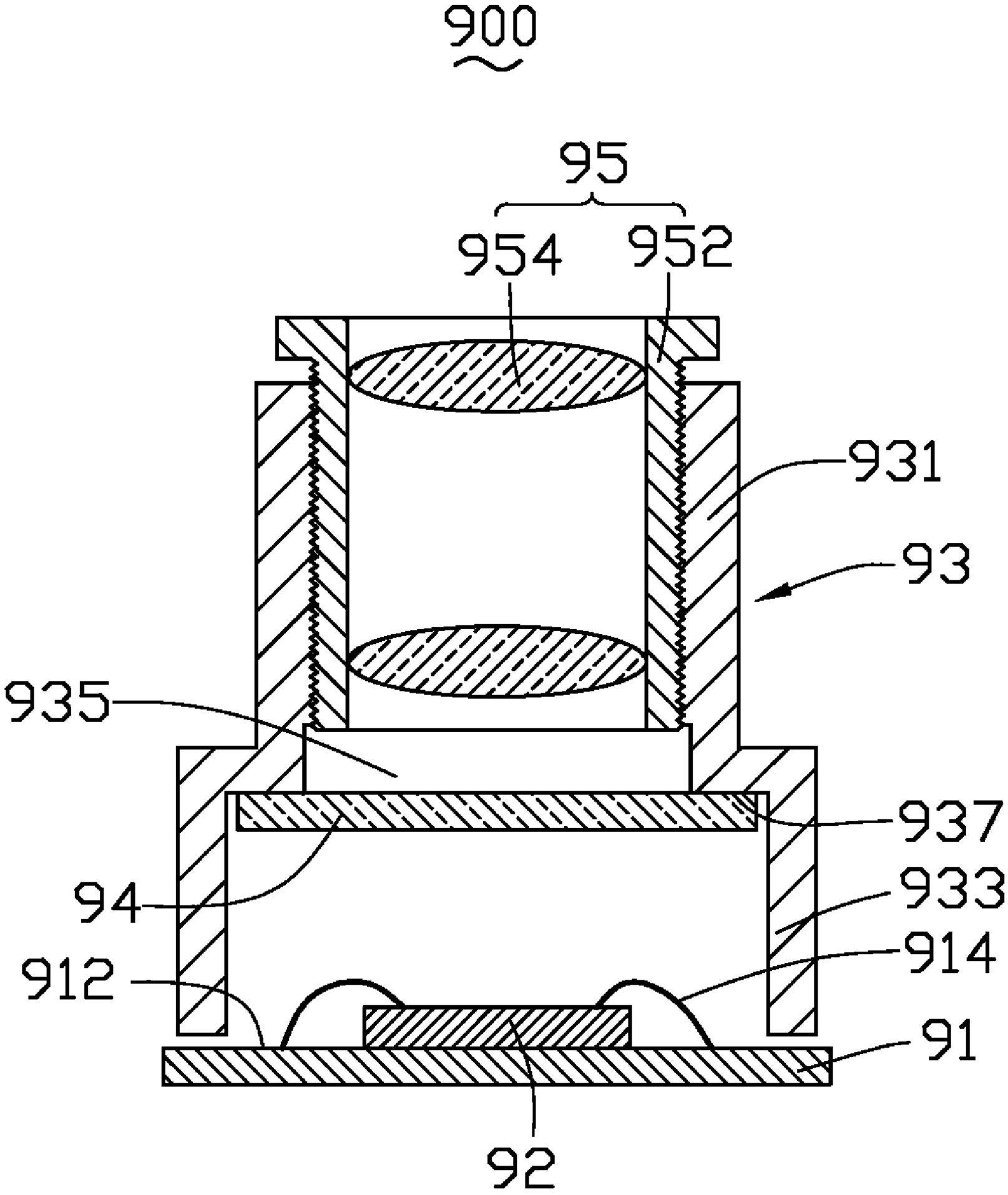
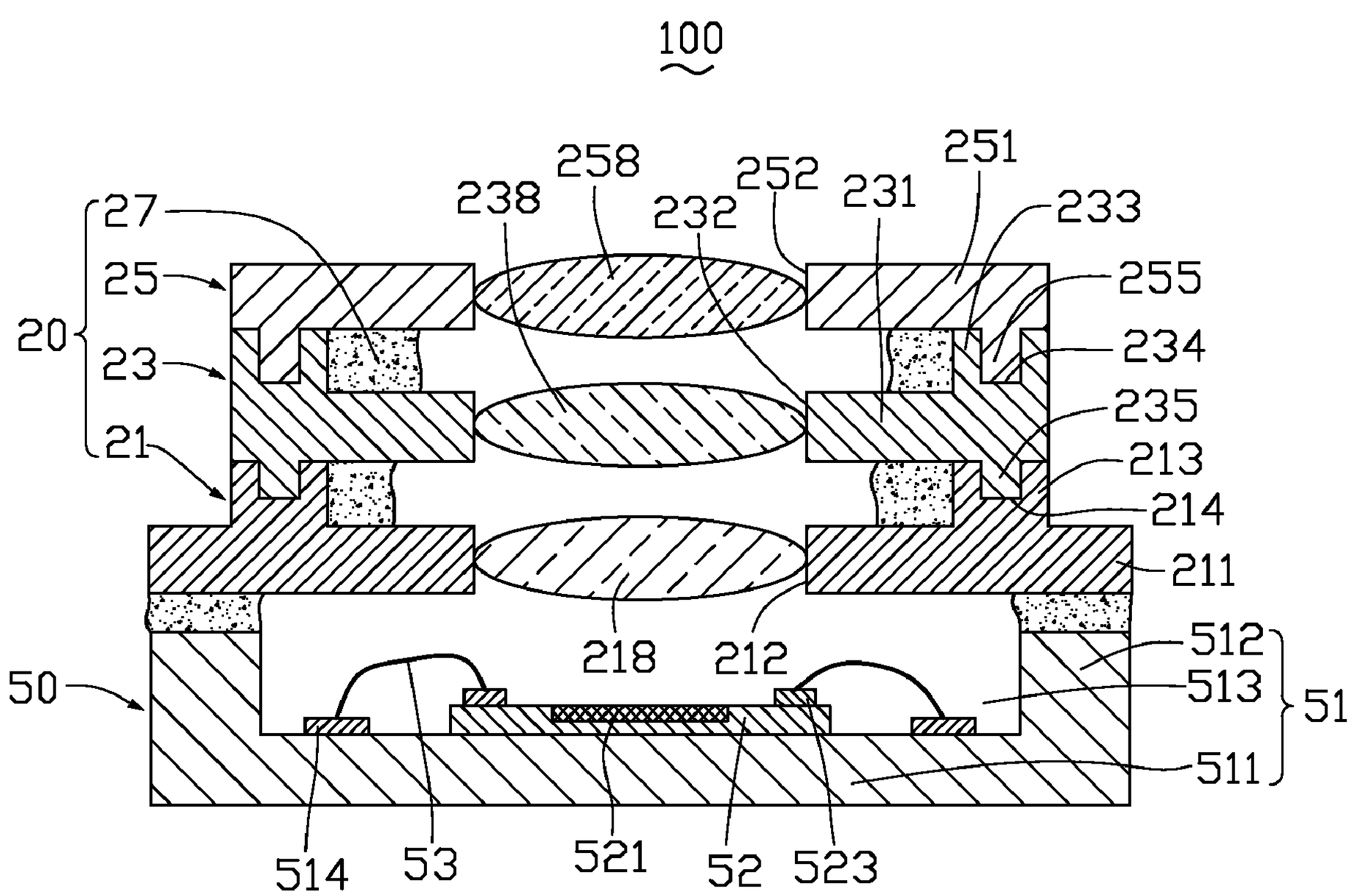


FIG. 1 (RELATED ART)


100
258
238
252
232
231
251
233
27
25
255
20
23
234
235
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214
211
218
212
512
50
513
51
511
514
53
521
52
523

FIG. 2

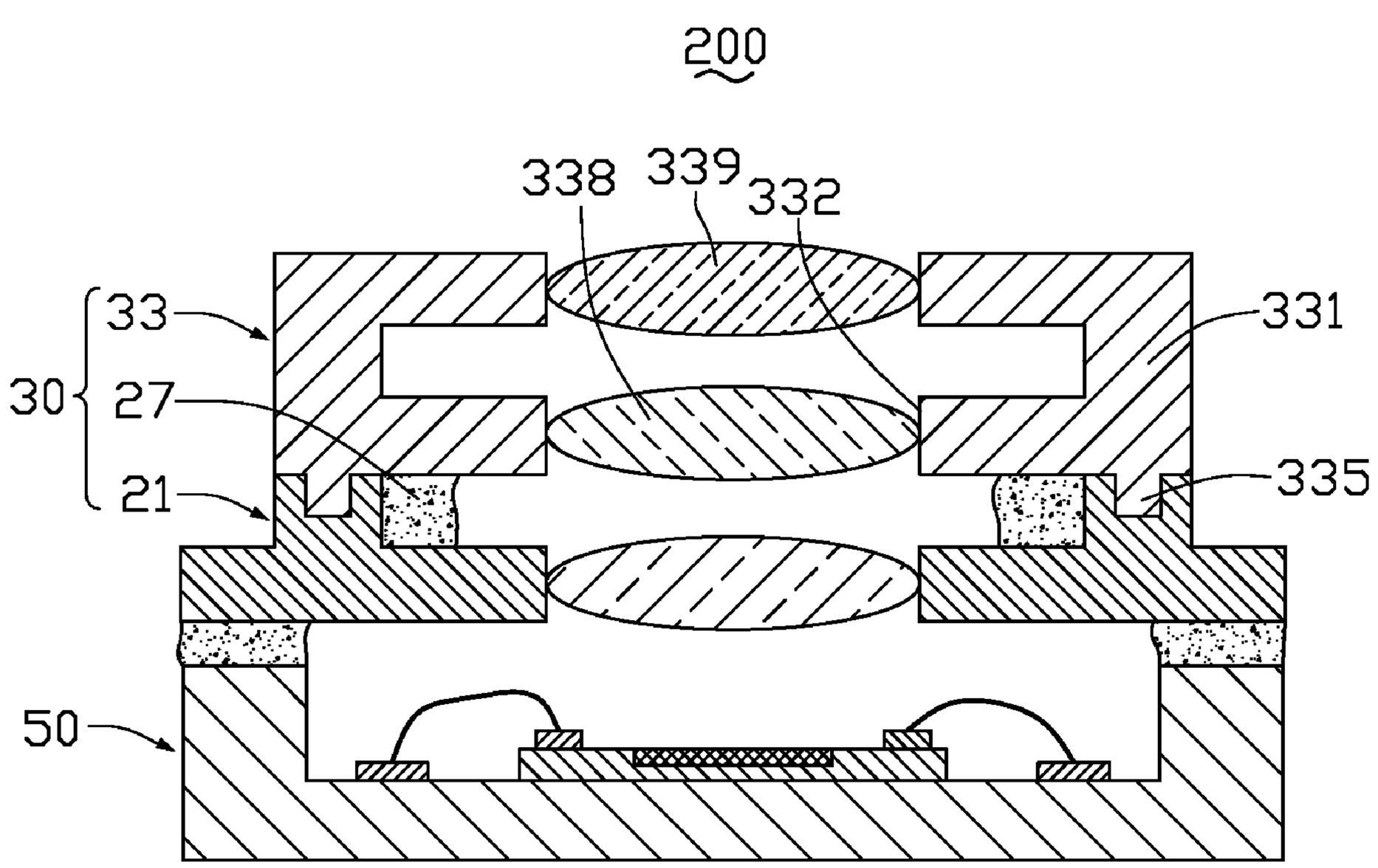

FIG. 3

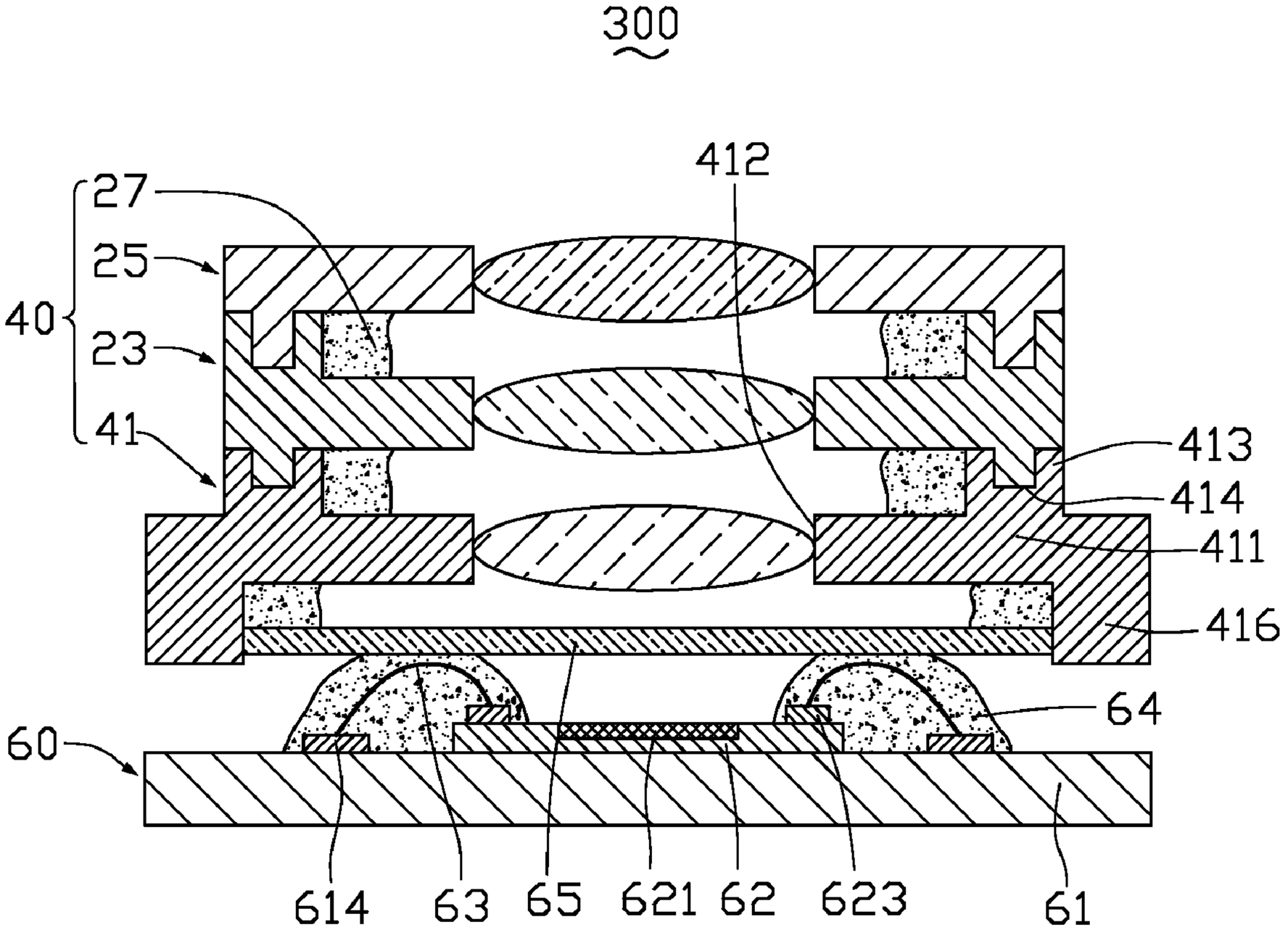

FIG. 4

LENS MODULE AND DIGITAL CAMERA MODULE USING SAME

BACKGROUND

1. Technical field

The present invention generally relates to lens modules and digital camera modules using the lens module and, more particularly, to a lens module and a digital camera module using the lens module, which are used in portable electronic devices, such as mobile phones, personal digital assistants (PDAs), or palm-top computers.

2. Description of the Related Art

With the ongoing development of microcircuitry and multimedia technology, digital cameras are now in widespread use. High-end portable electronic devices, such as mobile phones and PDAs, are being developed to be increasingly multi-functional. Many of these portable electronic devices are now equipped with digital cameras.

FIG. **1** (related art) shows a typical digital camera module **90**, which includes a substrate **91**, a chip **92**, a holder **93**, a transparent board **94**, and a lens module **95**. The substrate **91** has an upper surface **912**, which is provided with a predetermined circuitry formed thereon. The chip **92** is attached to the upper surface **912** and is electrically connected to the substrate **91** via a plurality of conductive wires **914**. The lens holder **93** includes a cylinder portion **931** configured for receiving the lens module **95**, a seat portion **933** from which the cylinder portion **931** projects, and a through hole **935** defined through the respective interiors of the cylinder portion **931** and the seat portion **933**. The cylinder portion **931** has a diameter smaller than that of the seat portion **933**, thereby forming a step surface **937** therebetween. The transparent board **94** is attached to the step surface **937** of the lens holder **93**. The lens module **95** includes a barrel **952** and at least one lens **954** fixed to the barrel **952**.

The lens module **95** is received in and screwed into the cylinder portion **931** of the holder **93**. The seat portion **933** is attached to the substrate **91** and receives the chip **92** therein.

In the aforesaid digital camera module **90**, the lens module **95** is threadedly engaged with the cylinder portion **931** of the holder **93**, which may create certain problems. As such, a manual focusing procedure is needed in order to set the lens module **95** to form a focused image on the chip **92**, which is time consuming and may adversely affect the production yield. Additionally, an optical axis of the lens module **95** may incline and be displaced from a center of the chip **92**, which may accordingly adversely affect the quality of images formed by the digital camera module **90**.

Therefore, an improved lens module and an improved digital camera module using the lens module are desired in order to overcome the above-described shortcomings.

SUMMARY

In one aspect, a lens module is provided. The lens module includes a first lens assembly and a second lens assembly. The first lens assembly includes a first fixture having a through hole defined therein, and at least one lens received in the through hole. The second lens assembly includes a second fixture having a through hole defined therein, and at least one lens attached to the second fixture. One of the first fixture and the second fixture has a slotted annular ring protruding therefrom with an annular slot defined therein, the other has a male annular ring extending therefrom, and the slotted annular ring and the male annular ring matingly engage with each other to fix the first lens assembly and second lens assembly together.

In another aspect, a digital camera module is provided. The digital camera module includes a lens module and a chip package. The lens module includes a first lens assembly and a second lens assembly. The first lens assembly includes a first fixture having a through hole defined therein and at least one lens received in the through hole. The second lens assembly includes a second fixture having a through hole defined therein and at least one lens attached to the second fixture. One of the first fixture and the second fixture has a slotted annular ring protruding therefrom with an annular slot defined therein. The other has a male annular ring extending therefrom, and the slotted annular ring and the male annular ring matingly engage with each other to fix the first lens assembly and second assembly together. The chip package is mounted in a light path of the lens module to receive a focused image formed by the lens module.

Other advantages and novel features will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the present lens module and digital camera module can be better understood with reference to the following drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the present lens module and digital camera module. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. **1** is a cross-sectional view of a typical digital camera module;

FIG. **2** is a schematic, cross-sectional view of a digital camera module having a lens module, according to a first preferred embodiment;

FIG. **3** is a schematic, cross-sectional view of a digital camera module having a lens module, according to a second preferred embodiment; and

FIG. **4** is a schematic, cross-sectional view of a digital camera module having a lens module, according to a third preferred embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings in detail, FIG. **2** shows a digital camera module **100** according to a first preferred embodiment. The digital camera module **100** is constructed to include a lens module **20** and a chip package **50** disposed in a light path of the lens module **20** to receive a focused image formed by the lens module **20**.

The lens module includes a first lens assembly **21**, a second lens assembly **23**, a third lens assembly **25**, and an adhesive **27**.

The first lens assembly **21** includes a first fixture **211** and a first lens **218** mounted to the first fixture **211**. The first fixture **211** is substantially board shaped and has a top surface (not labeled), a bottom surface (not labeled), a through hole **212** defined in a middle portion thereof and penetrating through the top surface and the bottom surface, and a first top annular ring **213** (i.e., a slotted annular ring) upwardly projecting from the top surface thereof. The through hole **212** is used for receiving the first lens **218** therein. The first top annular ring **213**, which is advantageously integrally formed with the top surface of the first fixture **211**, has a first annular slot **214** defined in a top surface thereof. Further, the first annular slot **214** faces away from the top surface of the first fixture **211**.

The second lens assembly **23** has a similar structure to that of the first lens assembly **21** and includes a second fixture **231** and a second lens **238** mounted to the second fixture **231**. The second fixture **231** is substantially board shaped. The second fixture **231** has a top surface (not labeled), a bottom surface (not labeled), a through hole **232**, a second top annular ring **233** (i.e., a slotted annular ring) with a second annular slot **234** defined therein, and a second bottom annular ring **235** (i.e., a male annular ring) downwardly projecting away from the bottom surface thereof. Beneficially, the second top annular ring **233** and the second bottom annular ring **235** are, respectively, integral with the top surface and the bottom surface of the second fixture **231**. The second lens **238** is received in the through hole **232** of the second fixture **231** and is fixed to the second fixture **231**. The second bottom annular ring **235** has a configuration approximately equal to that of the first annular slot **214** so that the second bottom annular ring **235** can tightly and matingly engage with the first top annular ring **213** of the first fixture **211**, via the first annular slot **214**.

The third lens assembly **25** has a similar structure to that of the first lens assembly **21** and includes a third fixture **251** and a third lens **258** mounted to the third fixture **251**. The third fixture **251** is substantially board shaped and has a top surface (not labeled), a bottom surface (not labeled), a through hole **252**, and a third bottom annular ring **255** (i.e., a male annular ring) downwardly and integrally projecting from the bottom surface thereof. The third lens **258** is received in the through hole **252** of the third fixture **251** and is fixed to the third fixture **251**. The third bottom annular ring **255** has a configuration approximately equal to that of the second annular slot **234** so that the third bottom annular ring **255** can tightly engage in the second annular slot **234** of the second top annular ring **233**.

In assembly the lens module **20**, the second bottom annular ring **235** of the second lens fixture **231**, and the third bottom annular ring **255** of the third lens fixture **251** are, respectively, inserted in and engage with the first annular slot **214** of the first lens fixture **211** and the second annular slot **234** of the second lens fixture **231**. Meanwhile, the optical axes of the first lens **218**, the second lens **238**, and the third lens **258** are aligned with each other.

In order to enforce the connections between two adjacent lens assemblies, the adhesive **27** (e.g., glue, epoxy resin, etc.) should preferably be applied between each two adjacent lens fixtures, in order to fix neighboring lens fixtures to each other.

The chip package **50** includes a carrier **51**, a chip **52**, and a plurality of wires **53**. The carrier **51** includes a base board **511**, a sidewall **512** upwardly extending from a periphery of the base board **511**, and a cavity **513** cooperatively formed by the base board **511** and the sidewall **512** for receiving electronic components. The carrier **511** further includes a plurality of contacts **514** arranged on a top surface of the base board **511** and contained in the cavity **513**. The chip **52** can be, for example, a complementary metal-oxide-semiconductor transistor (CMOS) image sensor or a charge coupled device (CCD) image sensor. The chip **52** is received in the cavity **513** and is attached to the base board **511**. A top surface of the chip **52** includes an active area (e.g., a photo-registering zone) **521** and a number of pads **523** arranged around the active area **521**. One end of each wire **53** is connected/joined with a respective pad **523** of the chip **52**, and the other end of the wire **53** is connected/joined with a respective contact **514** of the carrier **51**.

The bottom surface of the first fixture **211** of the lens module **20** is adhered to the top of the sidewall **512** of the carrier **51** of the chip package **50** to enclose the chip **52** in the cavity **513**. The sidewall **512** of the carrier **51** has a predetermined height to separate the lens module **20** from the chip **52** at a suitable distance according to a desired focal length for the lens module **20**. In such a manner, the lenses **218**, **238**, **258** of the lens module **20** can cooperatively form a focused image on the active area **521** of the chip **52**. As is to be understood, the digital camera **100** has a fixed focus, according to such a configuration.

Referring to FIG. **3**, a digital camera module **200**, according to a second preferred embodiment, is shown. The digital camera module **200** has a similar structure to that of the digital camera module **100** and includes a lens module **30** and a chip package **50** arranged in a light path of the lens module **30**. The lens module **30** includes a first lens assembly **21**, a second lens assembly **33**, and an adhesive **27**. The digital camera module **200** is different from the digital camera module **100** mainly in the structure of the second lens assembly **33**.

The second lens assembly **33** includes a second fixture **331**, a second lens **338**, and third lens **339**. The second fixture **331** has a through hole **332** defined therein, and the second lens **338** and third lens **339** are received in the through hole **332**. The second fixture **331** has a second bottom annular ring **335** downwardly and integrally protruding from a bottom surface thereof. In general, the second fixture **331** has a similar structure to that of the engaged second fixture **231** and the third fixture **251** of the digital camera module **100**, except that the second fixture **331** of the digital camera module **200** has a one-piece structure.

Referring to FIG. **4**, a digital camera module **300**, according to a third preferred embodiment, is shown. The digital camera module **300** has a similar structure to that of the digital camera module **100** and includes a lens module **40** and a chip package **60** disposed in a light path of the lens module **40**. The lens module **40** includes a first lens assembly **41** having a first fixture **411**, a second lens assembly **23**, and a third lens assembly **25**. The digital camera module **300** differs from the digital camera module **100** mainly in the structure of the first fixture **411**, the structure of the chip package **60**, and the means of mounting the lens module **40** to the chip package **60**.

The first fixture **411** of the lens module **40** includes a through hole **412** defined therethrough, a first top annular ring **413** within a first annular slot **414** defined therein, and a frame section **416** downwardly and integrally protruding from a periphery of a bottom surface of the first fixture **411**.

The chip package **60** includes a carrier **61**, a chip **62**, a plurality of wires **63**, an adhesive **64**, and a cover **65**. The carrier **61** is board shaped and includes a plurality of contacts **614** arranged on a top surface thereof. The chip **62** is mounted to the top surface of the carrier **61** and is surrounded by the contact **614**. The chip **62** has a top surface, an active area **621**, and a plurality of pads **623** arranged on the top surface. The wires **63** electrically connect the pads **623** of the chip **62** to the contacts **614** of the carrier **61**. The adhesive **64** is applied to the top surface of the carrier **61**, around the chip **62** in a manner so as to cover/encapsulate the pads **623**, joints of the pads **623** and the wires **63**, the wires **63**, and joints of the wires **63** and the contacts **614**. The cover **65** is adhered to the adhesive **64** to hermetically enclose the active area **621** of the chip **62**.

In assembly of the digital camera module **300**, the frame section **416** of the first fixture **411** receives the cover **65** of the chip package **60**. In receiving the cover **65**, an inner side of the frame portion **416** tightly abuts against an outer side of the cover **65**, and the bottom surface of the first fixture **411** is adhered to the top surface of the cover **65**. The cover **65** supporting the lens module **40** is fixedly separated a predetermined distance, according to a focal length of the lens

module **40**, so that the lens module **40** can form a focused image on the active area **621** of the chip **62**.

It is to be understood that the positions of each slotted annular ring and the corresponding male annular ring can be exchanged with each other. For example, in the first preferred embodiment, the male annular ring **235** can be disposed on the top surface of the first fixture **21**, whilst the corresponding slotted annular ring **213** should, beneficially, be arranged on the bottom surface of the second fixture **23**.

In addition, the annular ring in which the annular slot is defined can be omitted, and the annular slot can be directly defined in the top surface of the fixtures. Further, the annular rings can potentially be attached (e.g., mechanically, metallurgically, and/or adhesively) instead of being integral with a given fixture.

In the aforesaid preferred embodiments, the sidewall of the carrier and/or the cover of the chip package are configured to separate the lens module by a suitable distance, according to the focal length of the lens module, and the lens module can be directly mounted to the chip package to form a fixed-focus image on the chip. Therefore, there is no need for the process of adjusting the position of the lens module, and the assembling process of the digital camera module is easy and quick. In addition, there is minimal risk of mounting the lens module at a slant, so the image quality of the digital camera module may be, accordingly, much improved.

It is believed that the present embodiments and their advantages will be understood from the foregoing description, and it will be apparent that various changes may be made thereto without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the examples hereinbefore described merely being preferred or exemplary embodiments of the invention.

What is claimed is:

1. A lens module comprising:

a first lens assembly comprising a first fixture having a through hole defined therein and at least one lens received in the through hole; and

a second lens assembly comprising a second fixture having a through hole defined therein and at least one lens attached to the second fixture;

wherein one of the first fixture and the second fixture has a slotted annular ring protruding therefrom with an annular slot defined therein, the other has a male annular ring extending therefrom, and the slotted annular ring and the male annular ring matingly engage with each other to fix the first lens assembly and second lens assembly together.

2. The lens module as claimed in claim **1**, wherein the first fixture is board shaped and has a top surface and a bottom surface positioned opposite to the top surface, and the top surface has the slotted annular ring upwardly protruding therefrom, the slotted annular ring has an annular slot defined therein.

3. The lens module as claimed in claim **2**, wherein the first fixture further has a frame portion, and the frame portion downwardly protrudes from a periphery of the bottom surface of the first fixture.

4. The lens module as claimed in claim **1**, wherein the second fixture is board shaped and has a top surface and a bottom surface positioned opposite to the top surface, and the male annular ring downwardly protrudes from the bottom surface of the second fixture.

5. The lens module as claimed in claim **1** further includes an adhesive applied between two respective, adjacent surfaces of the first fixture and the second fixture.

6. A digital camera module comprising:

a lens module comprising:

a first lens assembly comprising a first fixture having a through hole defined therein and at least one lens received in the through hole; and

a second lens assembly comprising a second fixture having a through hole defined therein and at least one lens attached to the second fixture;

wherein one of the first fixture and the second fixture has a slotted annular ring protruding therefrom with an annular slot defined therein, the other has a male annular ring extending therefrom, and the slotted annular ring and the male annular ring matingly engage with each other to fix the first lens assembly and second lens assembly together; and

a chip package disposed in a light path of the lens module to receive a focused image formed by the lens module.

7. The digital camera module as claimed in claim **6**, wherein the first fixture is board shaped and has a top surface and a bottom surface positioned opposite to the top surface, and the top surface has the slotted annular ring upwardly protruding therefrom, the slotted annular ring has an annular slot defined therein.

8. The digital camera module as claimed in claim **7**, wherein the first fixture further has a frame portion, and the frame portion downwardly protrudes from a periphery of the bottom surface of the first fixture.

9. The digital camera module as claimed in claim **6**, wherein the second fixture is board shaped, and has a top surface and a bottom surface positioned opposite to the top surface, and the male annular ring downwardly protrudes from the bottom surface of the second fixture.

10. The digital camera module as claimed in claim **6**, wherein the lens module further comprises an adhesive applied between two respective adjacent surfaces of the first fixture and the second fixture.

11. The digital camera module as claimed in claim **6**, wherein the chip package comprises a carrier, a chip mounted to the carrier, and a plurality of wires electrically connecting the chip to the carrier.

12. The digital camera module as claimed in claim **11**, wherein the carrier comprises a base board and a sidewall upwardly protruding form the base board, a cavity being formed between the base board and the sidewall, the chip being received in the cavity.

13. The digital camera module as claimed in claim **11**, wherein chip package further comprises an adhesive and a cover; the adhesive is applied to the carrier, around the chip, and in a manner so as to cover a periphery of a top surface of the chip and to cover the wires and joints between the wires and the carrier; and the cover is fixed to the adhesive to enclose the chip.

* * * * *